(switch this with Mean *BR*)

Table I. Means and (*SD*s) of HR and HRV

HRV	3	4	6	8	10	12	14	*F*	*P* <
Mean HR	76.51 (6.37)	78.42 (7.33)	76.51 (6.37)	77.65 (6.89)	77.91 (6.57)	79.53 (7.70)	81.10 (8.05)	0.43	*ns*
Trough HR	60.94 (5.87)	62.27[a] (6.21)	63.27[a] (6.18)	64.36[a] (6.77)	65.58 (6.05)	67.22 (7.29)	69.88[b] (7.46)	3.35	.0146
Peak HR	93.78 (5.70)	96.38 (8.11)	94.61 (8.03)	92.87 (7.75)	92.07 (7.37)	93.23 (8.57)	93.83 (8.71)	0.36	*ns*
VLF	8.54 (3.85)	3.96 (2.19)	3.45 (2.29)	4.28 (3.40)	4.64 (3.27)	4.78 (3.80)	4.04 (2.83)	3.23	.05
LF	51.37[b] (16.11)	64.90[b] (21.85)	48.45 (21.96)	29.10 (13.95)	4.88[a] (2.45)	4.62[a] (3.38)	3.45[a] (2.38)	30.45	.0001
HF	1.52[a] (0.61)	2.02[a] (1.06)	3.31[a] (2.27)	3.37 (2.99)	15.68[b] (8.89)	9.17 (5.07)	6.22 (3.32)	10.71	.0001
Total variability	61.52 (17.16)	72.51[b] (21.36)	57.17 (20.34)	38.59[a] (14.52)	26.99[a] (9.02)	20.58[a] (7.91)	15.72[a] (6.65)	34.57	.0001
Peak power	4102.08 (1488.24)	4663.47 (1690.29)	3072.99 (1531.49)	1725.63 (980.32)	1076.56 (710.52)	643.81 (446.10)	404.54 (263.76)	18.44	.0001

Note. RR = respiratory rate; mean HR = beats per minute (bpm); trough HR = mean of lowest HR in respiratory-linked HR oscillations during the 5-min task; peak HR = mean of highest HR in respiratory-linked HR oscillations during the 5-min task; VLF = very low frequency HR oscillations (0.000–0.047 Hz), $(\text{bpm})^2/\text{Hz}$; LF = low-frequency HR oscillations (0.047–0.141 Hz), $(\text{bpm})^2/\text{Hz}$; HF = high-frequency HR oscillations (0.141–0.406 Hz), $(\text{bpm})^2/\text{Hz}$; total variability = total HR oscillation amplitude, across frequencies (0.000–0.5000 Hz), $(\text{bpm})^2/\text{Hz}$; peak power = frequency power of HRV at the target respiratory frequency, $(\text{bpm})^2/\text{Hz}$. Significant individual cell differences ($p < .05$) by Tukey's HSD test: Cells with superscript a have lesser values than cells marked with superscript b.

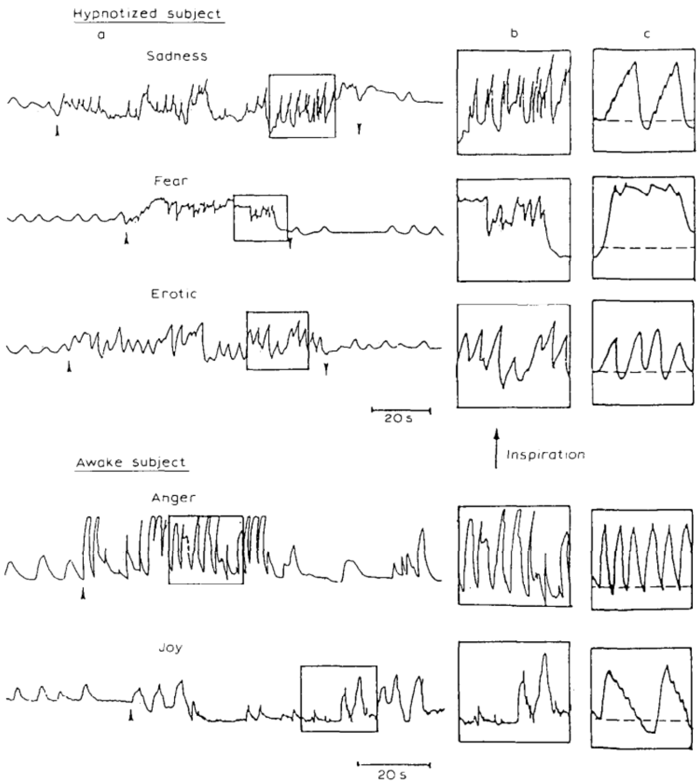


Fig. 1. (a) Changes of respiratory movements recorded in one subject reliving under deep hypnosis, personal emotional situations

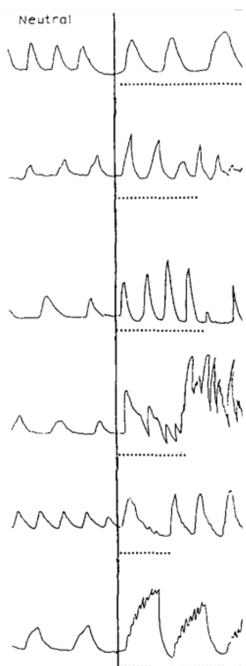


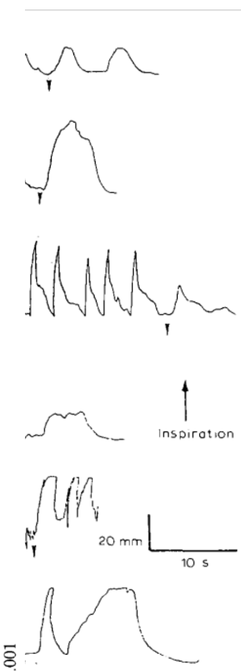
Fig. 3. Typical recordings of the
neutral 'non-emotional' breathi
breathing pattern has been div
underlinings). Quantitative meas
respiratory movements appear
spontaneous vocalizations. Dow:
The duration of each phase vari

TABLE I

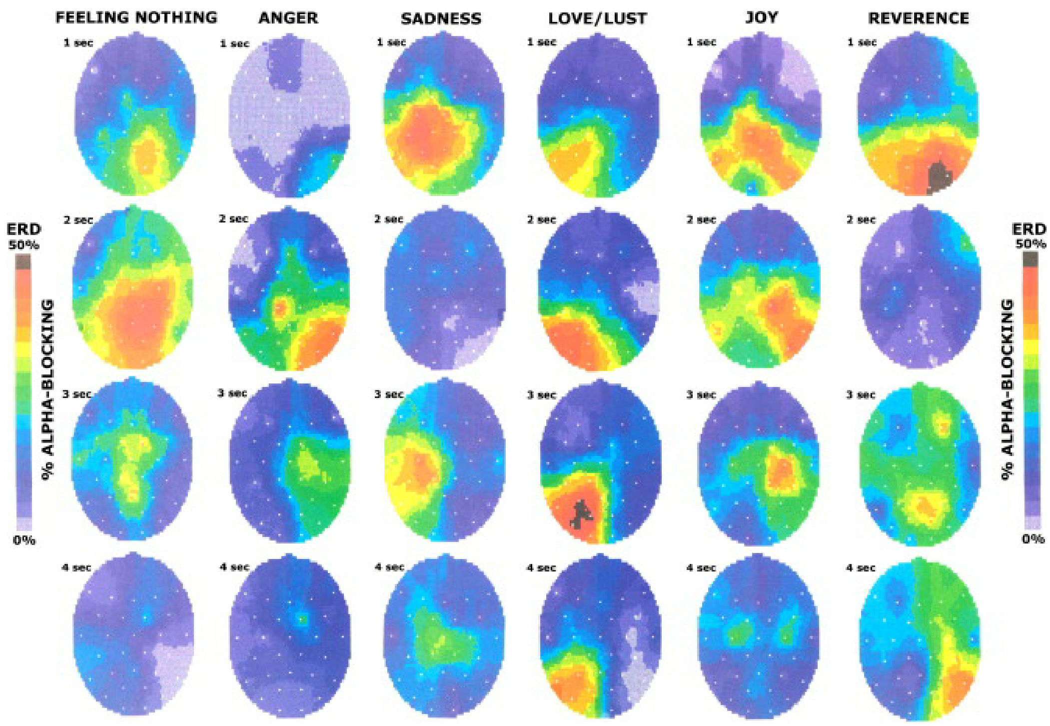
Mean values (± S.E.M.) of respiratory parameters (fundamental breathing cycles) for each emotional reproduction as compared (Student's paired t-test) to the corresponding neutral control values (in brackets)

Emotion	Respiratory parameters of the fundamental cycles			
	amplitude (mm)	*rate (Cy/min)*	*pause (% T_e)*	T_i/T_e
Tenderness	12.8 ± 1.8 (14.2 ± 1.5)	12.9 ± 1.6 (13.8 ± 1.5)	20.5 ± 3.5 (14.6 ± 3.8)	0.57 ± 0.07 (0.56 ± 0.07)
Erotic love	17.8 ± 1.9 (13.9 ± 1.4)	15.2 ± 1.9 (12.8 ± 1.2)	5.2 ± 1.8 * (18.7 ± 3.9)	0.73 ± 0.01 (0.60 ± 0.04)
Anger	33.6 ± 3.1 *** (12.0 ± 0.9)	33.1 ± 3.9 *** (12.8 ± 1.2)	0 *** (17.9 ± 5.1)	0.69 ± 0.10 (0.54 ± 0.05)
Joy-laugh	29.4 ± 2.0 *** (12.2 ± 1.1)	9.6 ± 0.9 * (13.4 ± 1.4)	7.7 ± 2.4 (14.5 ± 3.4)	0.38 ± 0.05 *** (0.63 ± 0.03)
Sadness-cry	27.7 ± 3.0 *** (10.8 ± 1.5)	11.4 ± 0.9 * (14.7 ± 1.2)	7.8 ± 2.8 (16.2 ± 3.7)	0.99 ± 0.14 * (0.63 ± 0.14)
Fear	38.6 ± 2.3 *** (10.2 ± 1.0)	7.2 ± 1.0 ** (14.1 ± 1.2)	0 *** (18.9 ± 3.9)	5.60 ± 0.90 *** (0.55 ± 0.04)

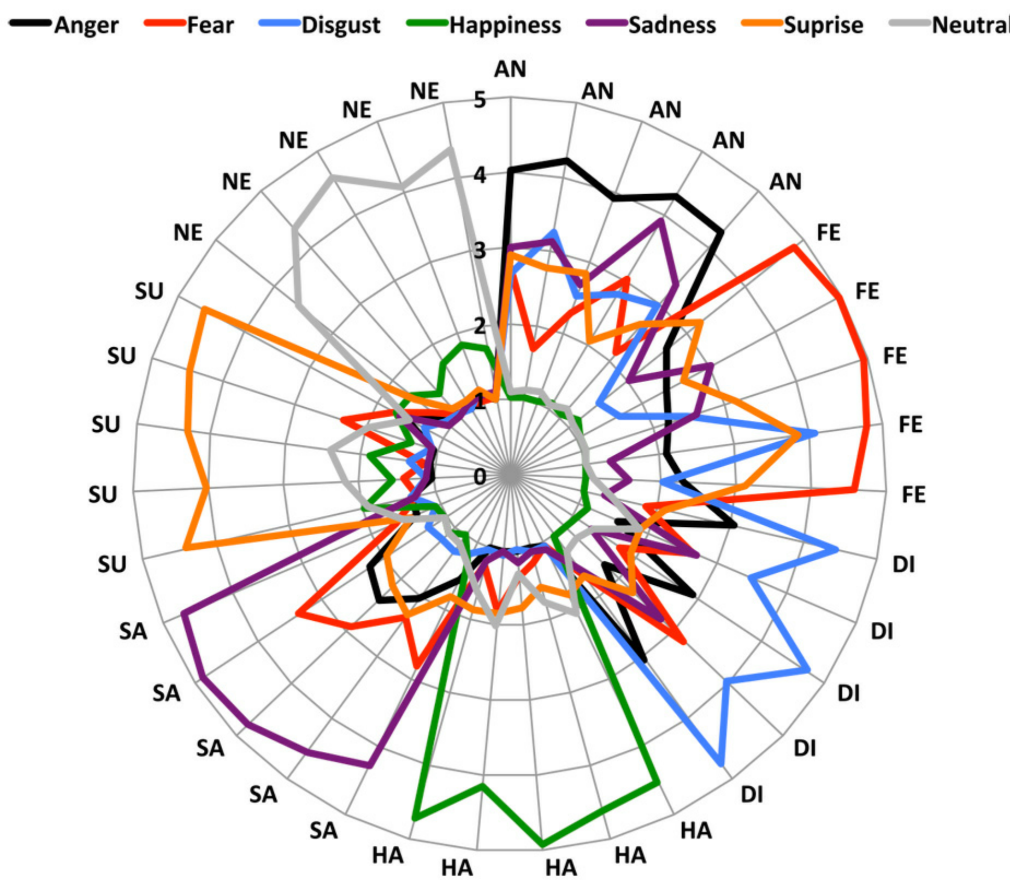
* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$



ıction preceded by periods of
ıction. The evolution of the
prototypical patterns (dotted
of the second phase in which
is usually accompanied by
on ending abruptly (see text).
: scales for pen deflection (in



FEELING NOTHING
ANGER
SADNESS
LOVE/LUST
JOY
REVERENCE
1 sec
2 sec
3 sec
4 sec
ERD
50%
% ALPHA-BLOCKING
0%



Anger
Fear
Disgust
Happiness
Sadness
Suprise
Neutral
0
1
2
3
4
5
AN
FE
DI
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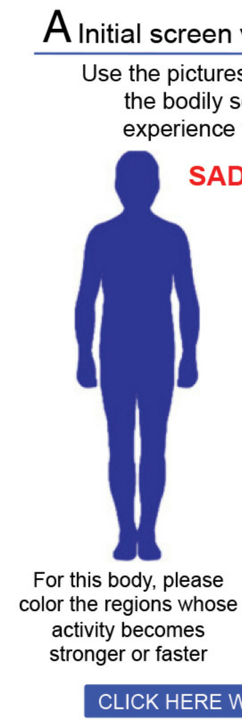
NE

Anger
Anxiety



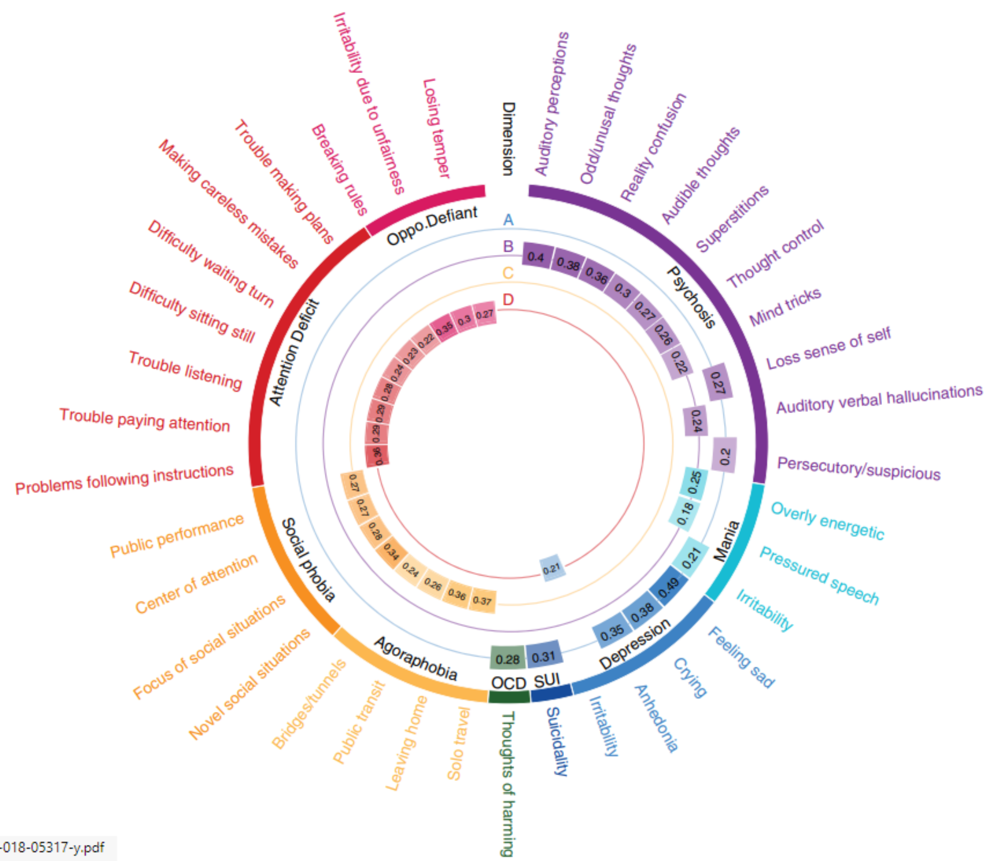


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Fig. 4 Connectivity-informed dimensions of psychopathology cross clinical diagnostic categories. **a** The mood dimension was composed of a mixture of depressive symptoms, suicidality, irritability, and recurrent thoughts of self-harm. **b** The psychotic dimension was composed of psychosis-spectrum symptoms, as well as two manic symptoms. **c** The fear dimension was comprised of social phobia and agoraphobia symptoms. **d** The externalizing behavior dimension showed a mixture of symptoms from attention-deficit and oppositional defiant disorders, as well as irritability from the depression section. The outermost labels are the item-level psychiatric symptoms (see details in Supplementary Data 1). The color arcs represent categories from clinical screening interview and the Diagnostic and Statistical Manual of Mental Disorders (DSM). Numbers in the inner rings represent sCCA loadings for each symptom in their respective dimension. Only loadings determined to be statistically significant by a resampling procedure are shown here

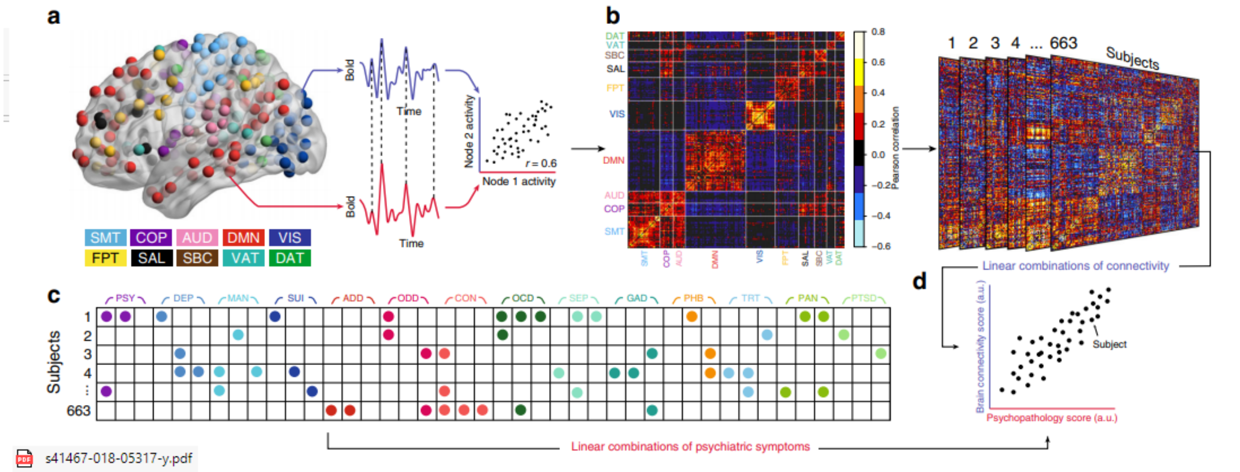

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Fig. 2 Schematic of sparse canonical correlation analysis (sCCA). **a** Resting-state fMRI data analysis schematic and workflow. After preprocessing, blood-oxygen-level dependent (BOLD) signal time series were extracted from 264 spherical regions of interest distributed across the cortex and subcortical structures. Nodes of the same color belong to the same a priori community as defined by Power et al.[10]. **b** A whole-brain, 264 × 264 functional connectivity matrix was constructed for each subject in the discovery sample ($n = 663$ subjects). **c** Item-level data from a psychiatric screening interview (111 items, based on K-SADS[62]) were entered into sCCA as clinical features (see details in Supplementary Data 1). **d** sCCA seeks linear combinations of connectivity and clinical symptoms that maximize their correlation. A priori community assignment: somatosensory/motor network (SMT), cingulo-opercular network (COP), auditory network (AUD), default mode network (DMN), visual network (VIS), fronto-parietal network (FPT), salience network (SAL), subcortical network (SBC), ventral attention network (VAT), dorsal attention network (DAT), Cerebellar and unsorted nodes not visualized. Psychopathology domains: psychotic and subthreshold symptoms (PSY), depression (DEP), mania (MAN), suicidality (SUI), attention-deficit hyperactivity disorder (ADD), oppositional defiant disorder (ODD), conduct disorder (CON), obsessive-compulsive disorder (OCD), separation anxiety (SEP), generalized anxiety disorder (GAD), specific phobias (PHB), mental health treatment (TRT), panic disorder (PAN), post-traumatic stress disorder (PTSD)

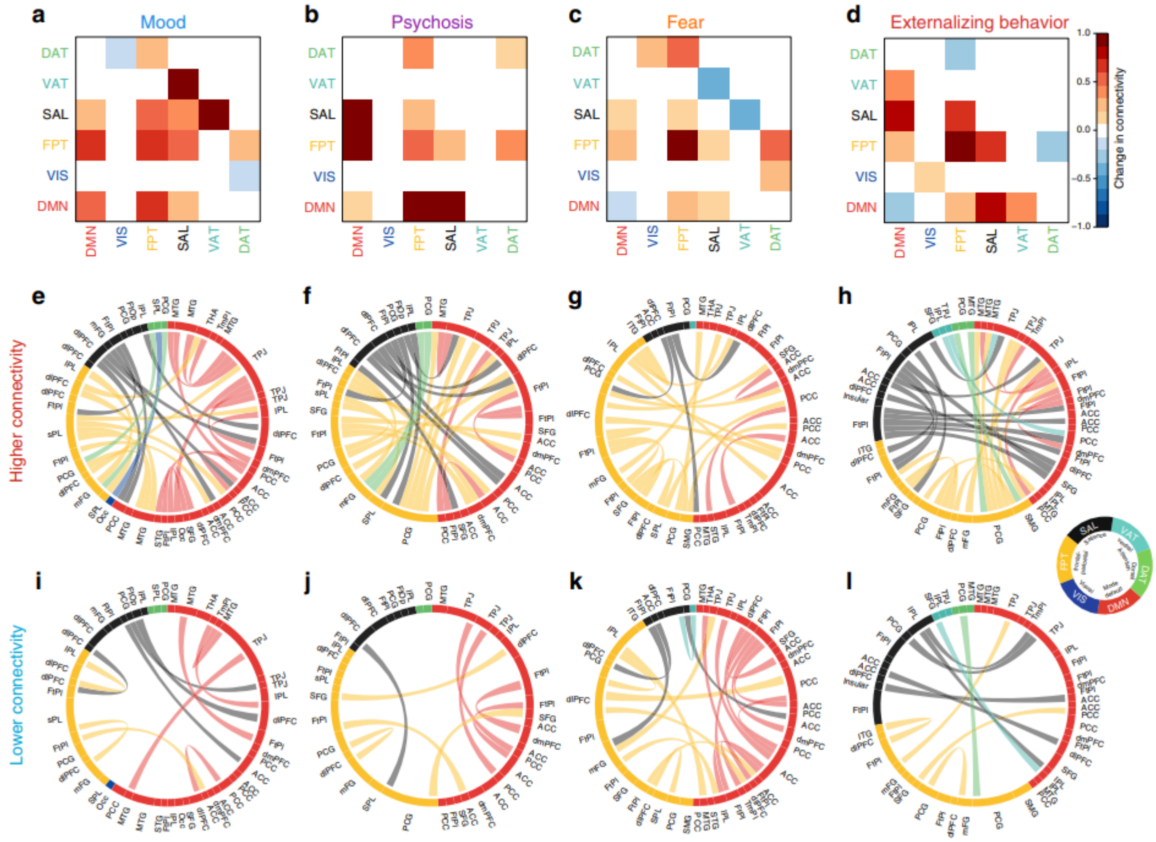

Fig. 5 Patterns of within- and between-network connectivity contribute to linked psychopathological dimensions. **a**–**d** Modular (community) level connectivity pattern associated with each psychopathology dimension. Both increased (**e**–**h**) and diminished (**i**–**l**) connectivity in specific edges contributed to each dimension of psychopathology. The outer labels represent the anatomical names of nodes. The inner arcs indicate the community membership of nodes. The thickness of the chords represents the loadings of connectivity features

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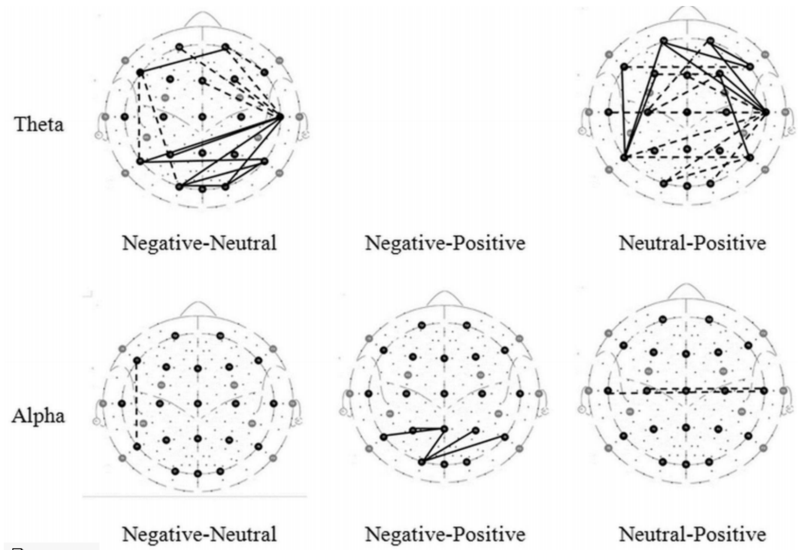

Figure 1. Brain maps of correlation. The lines connecting electrode sites indicate significant higher (solid) and lower (dashed) of correlation values for condition listed on left site.
doi:10.1371/journal.pone.0095415.g001

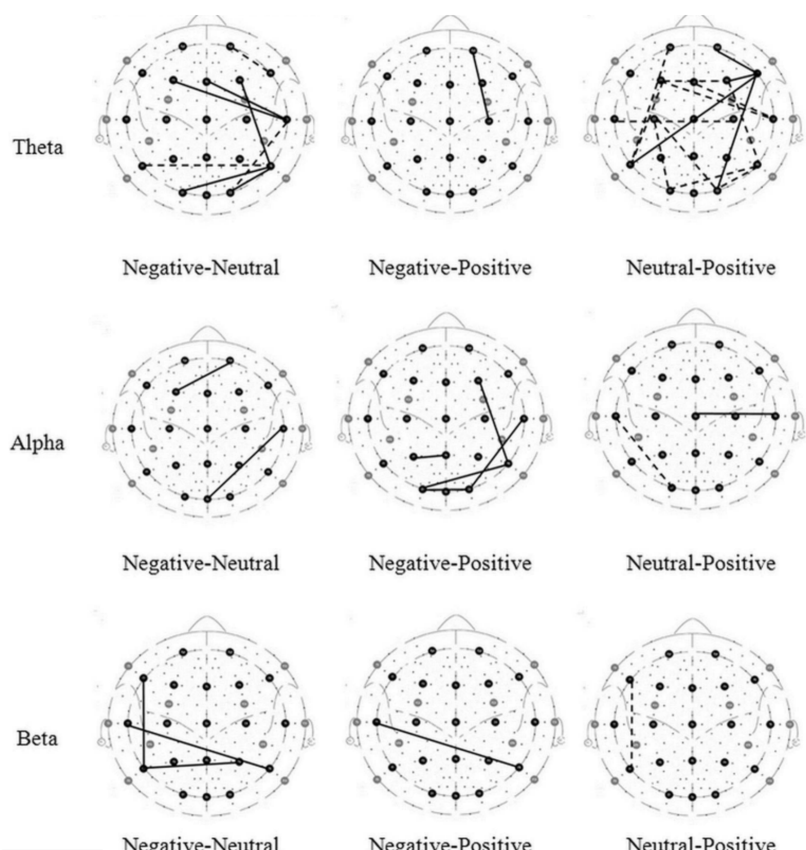

Figure 2. Brain maps of coherence. The lines connecting electrode sites indicate significant higher (solid) and lower (dashed) of coherence values for condition listed on left site.
doi:10.1371/journal.pone.0095415.g002

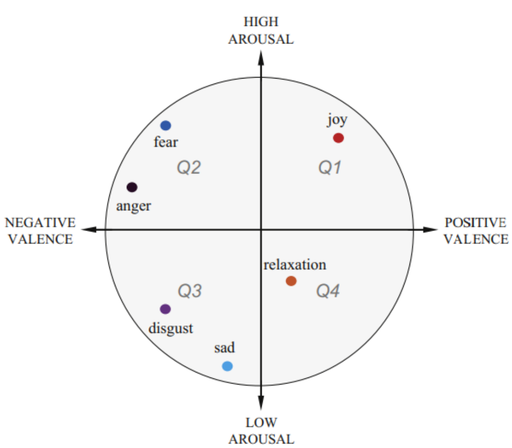

Fig. 1. Two-dimensional emotion model.

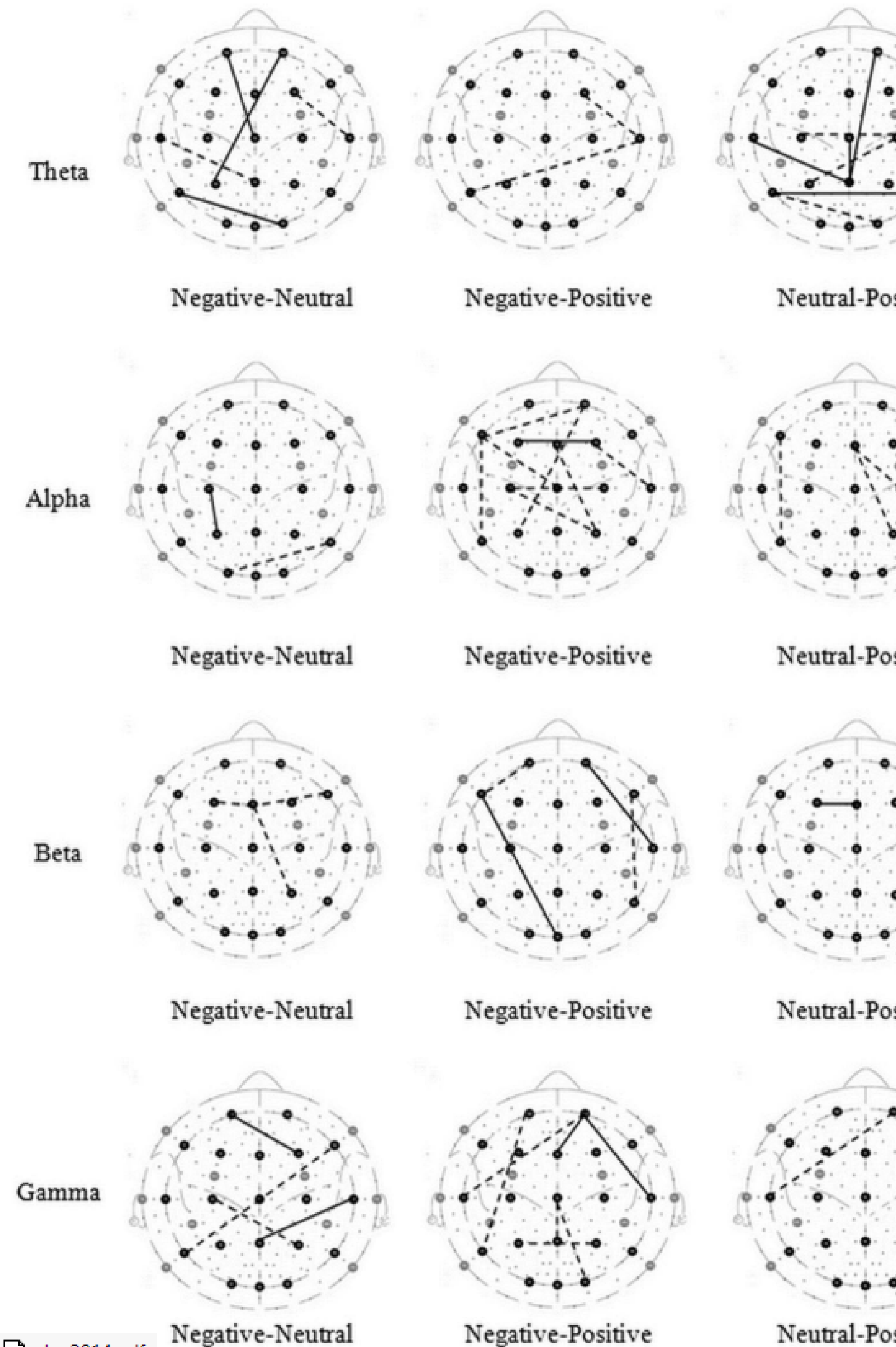

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Figure 3. Brain maps of phase synchronization index. The lines connecting electrode sites indica
(dashed) of phase synchronization index for condition listed on left site.
doi:10.1371/journal.pone.0095415.g003

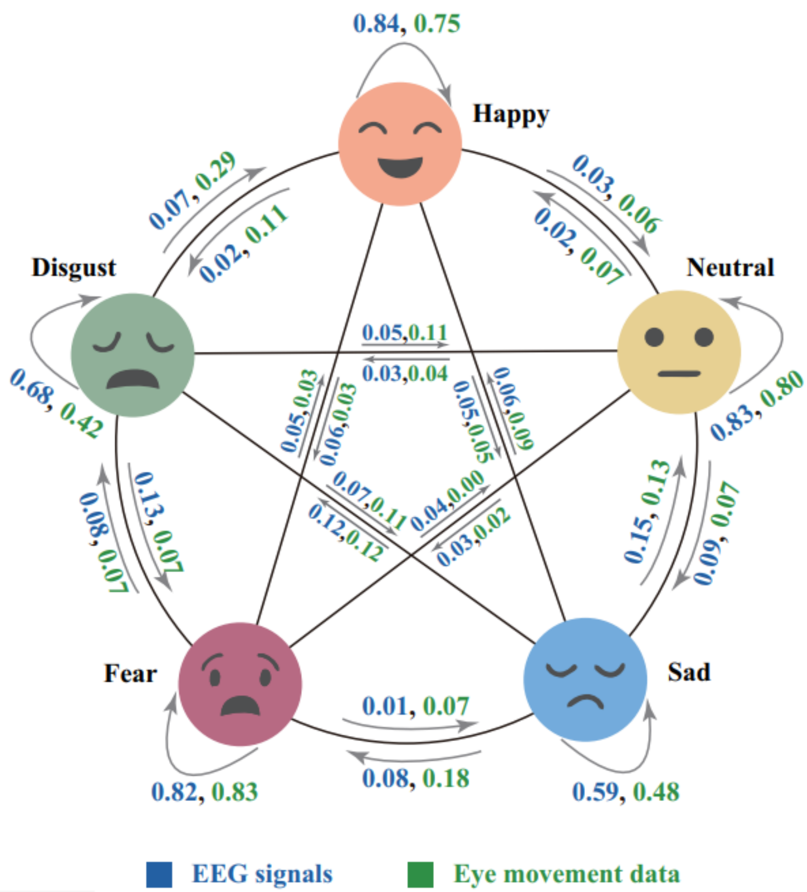

Fig. 9. Confusion graph of the EEG functional connectivity network feature and eye movement data in classifying the five emotions: disgust, fear, sadness, happiness, and neutrality.

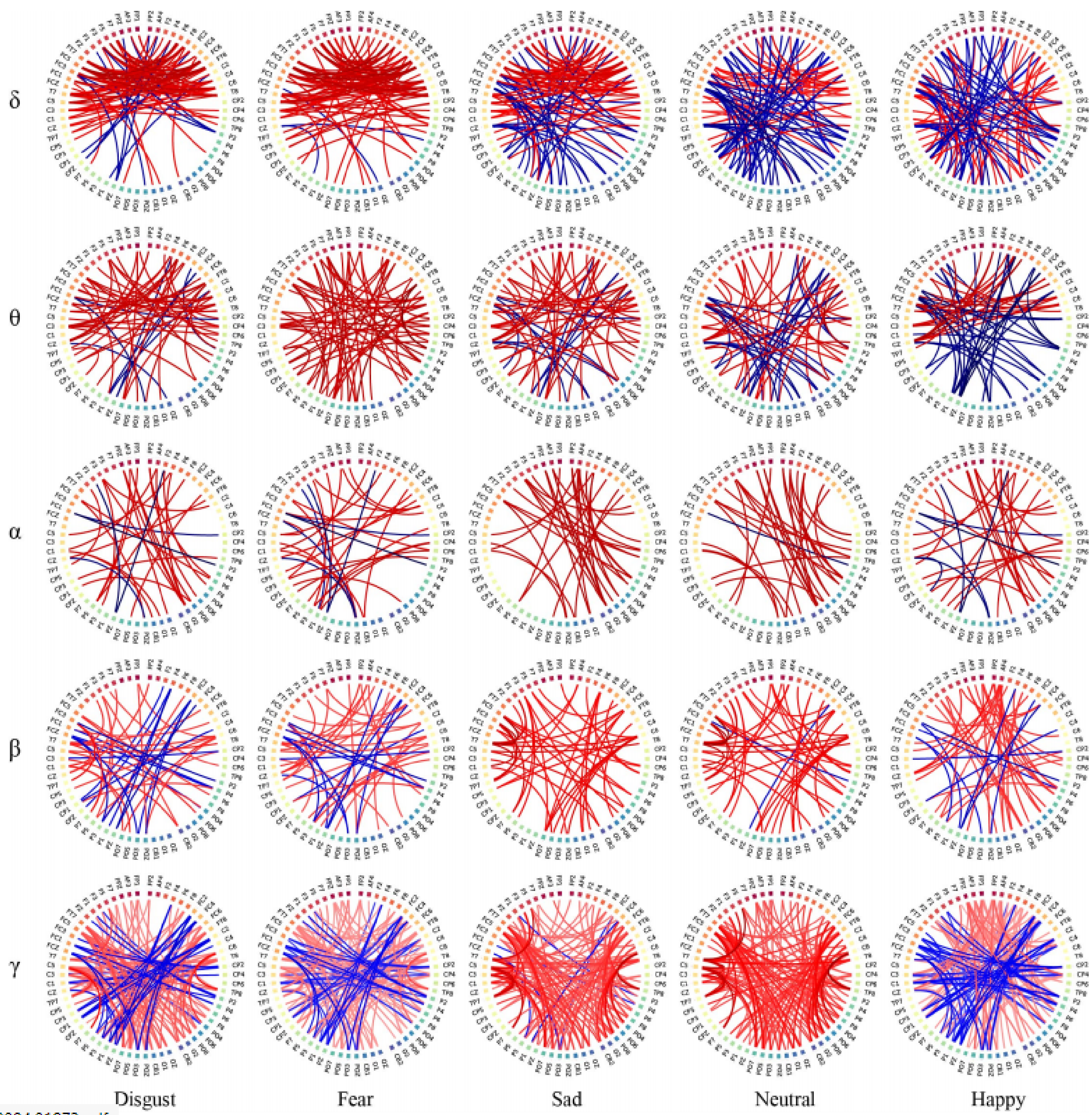

Fig. 11. The brain functional connectivity patterns for the five emotions in the five frequency bands with correlation as connectivity metric. In each subfigure, the positive and negative associations are drawn in red and blue colors, respectively, with darker line colors reflecting larger absolute values of association weights. In addition, the 62 nodes in each circle denote the 62 EEG electrodes located according to the following criterion: 1) the electrodes in the left and right cerebral regions lie in the left and right parts of the circle, respectively; 2) the electrodes in the frontal, temporal, parietal, and occipital areas are displayed from the top to bottom of each circle.

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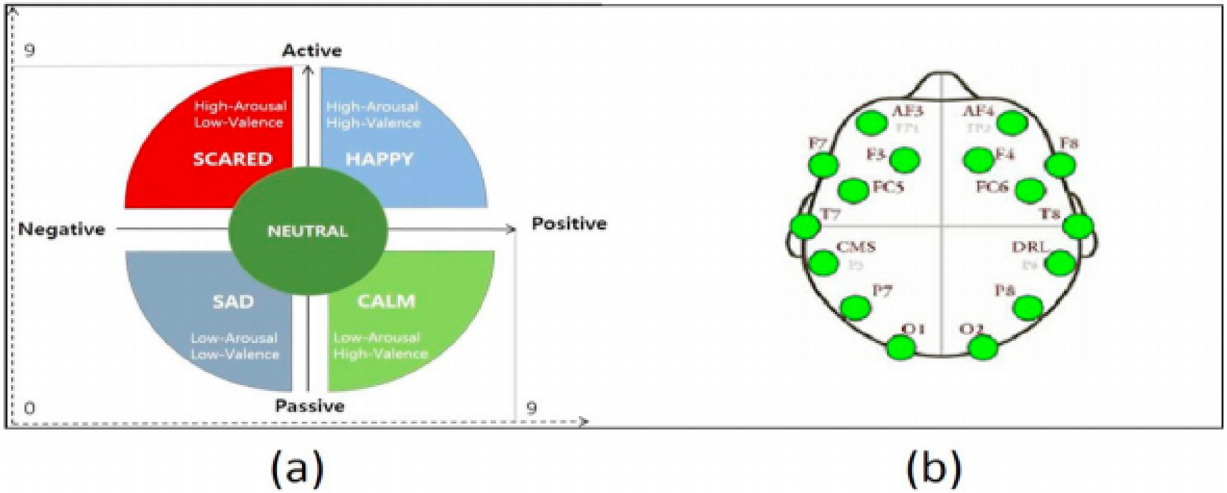

Fig. 2. Pictorial representation of: (a) Valence-Arousal model depicting emotions (b) Emotiv Epoc+ device with 14 sensors.

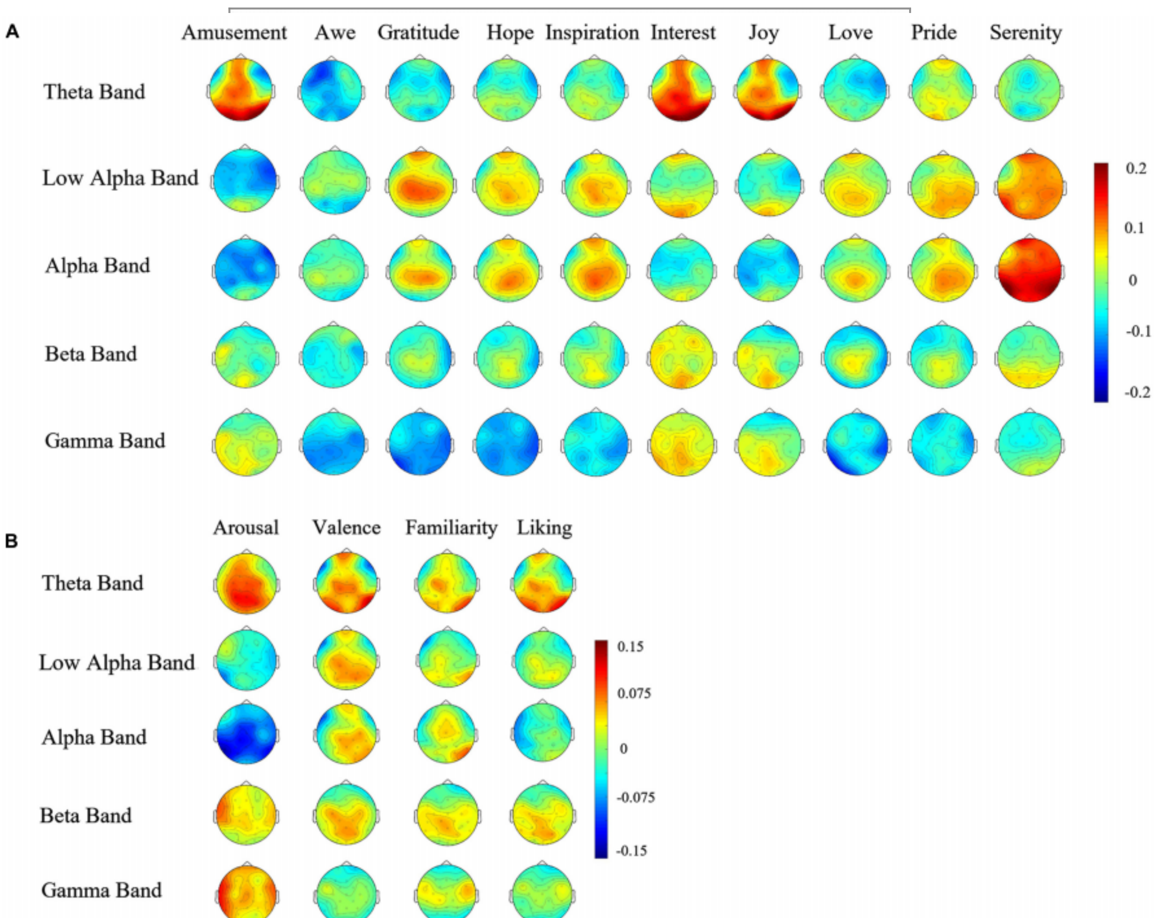

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FIGURE 4 | (A) Correlations between spectral power and ten positive emotion ratings Topographies of the correlation coefficients between the spectral powers in different frequency bands and the emotional experience ratings. **(B)** Correlations between spectral power and four emotion dimensions Topographies of the correlation coefficients between the spectral powers in different frequency bands and the emotional experience ratings on arousal, valence, familiarity, and liking.

TABLE 2 | The binary classification accuracies on the 14 emotional experience items.

Participant	Accuracy (%)													
	Amusement	Awe	Gratitude	Hope	Inspiration	Interest	Joy	Love	Pride	Serenity	Arousal	Valence	Familiarity	Liking
1	74.2	84.1	76.6	84.8	86.3	82.0	76.1	79.7	83.4	77.4	81.3	80.4	74.7	78.7
2	84.0	81.7	84.6	83.2	76.6	78.9	85.2	83.7	84.9	85.7	87.0	84.2	76.6	76.0
3	81.1	83.0	85.1	80.9	83.6	80.1	86.4	82.8	82.0	84.4	82.3	82.9	79.8	83.2
4	77.9	73.9	74.3	70.6	68.8	72.4	67.3	76.1	76.1	70.6	73.1	68.9	69.4	73.1
5	83.6	78.8	82.3	78.9	84.3	82.9	78.1	80.2	84.8	82.8	79.9	83.1	83.3	86.3
6	79.8	79.2	83.7	82.4	74.7	75.2	78.1	73.3	78.4	86.6	87.3	82.7	78.9	82.4
7	85.7	82.4	85.8	82.7	82.8	83.7	83.4	82.3	80.4	82.0	81.0	85.4	86.3	79.9

	Amusement	Awe	Gratitude	Hope	Inspiration	Interest	Joy	Love	Pride	Serenity	Arousal	Valence	Familiarity	Liking
Amusement	–	−0.49*	−0.10	0.13	0.25	0.75*	0.85*	0.17	0.15	−0.18	0.31*	0.53 *	0.48*	0.64*
Awe		–	0.60*	0.53*	0.50*	0.05	−0.17	0.15	0.54*	0.48*	−0.19	0.22	−0.06	0.15
Gratitude			–	0.91*	0.82*	0.36*	0.33*	0.75*	0.81*	0.51*	−0.19	0.70*	0.19	0.59*
Hope				–	0.95*	0.55*	0.57*	0.71*	0.88*	0.44*	−0.07	0.86*	0.34*	0.75*
Inspiration					–	0.67*	0.65*	0.56*	0.93*	0.30	0.12	0.88*	0.48*	0.81*
Interest						–	0.88*	0.38*	0.56*	0.17	0.21	0.80*	0.54*	0.89*
Joy							–	0.47*	0.56*	0.11	0.21	0.85*	0.60*	0.90*
Love								–	0.51*	0.43*	−0.24	0.66*	0.09	0.58*
Pride									–	0.28	0.14	0.80*	0.54*	0.75*
Serenity										–	−0.78*	0.36*	0.03	0.30
Arousal											–	0.01	0.19	0.11
Valence												–	0.58*	0.96*
Familiarity													–	0.64*
Liking														–

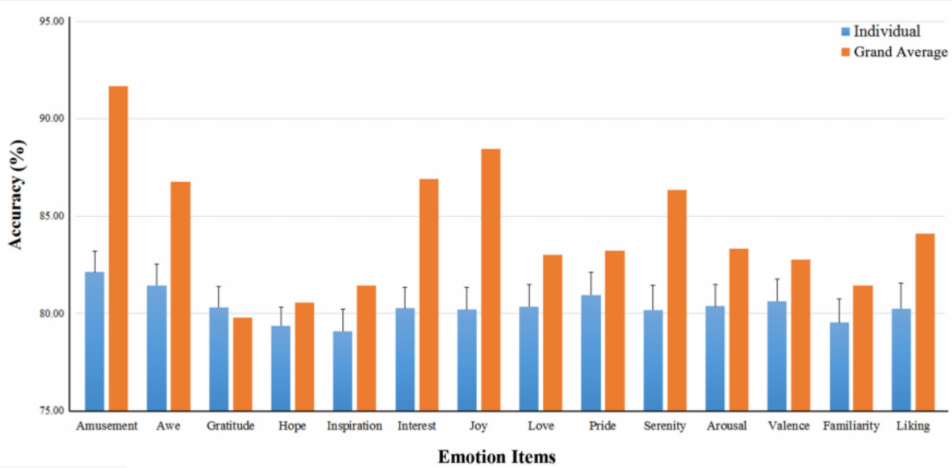


FIGURE 5 | Binary classification accuracies on the ten positive emotion experience. The binary classification accuracies on the 14 emotional experience items. The blue bars show the individual-based accuracies and their standard deviations (the error bars); The yellow bars are the accuracies using the grand-average based features.

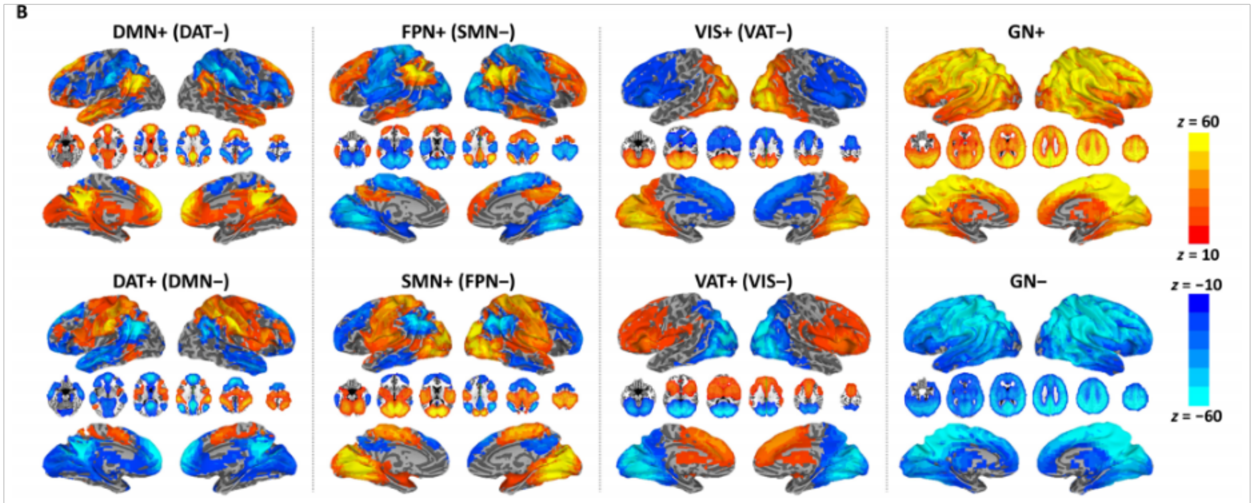


Fig. 1. Level of behavioral responsiveness across datasets and CAPs. (**A**) Dataset 1 (propofol-SHH) adopted Ramsay scale. Dataset 2 (propofol-WI) adopted observer's assessment of alertness/sedation (OAAS). Dataset 3 (ketamine) adopted a button press task for every 30 s. Reaction time (RT) in milliseconds with respect to each instruction was recoded. By comparing the timing of verbal instruction and actual responsiveness during and after ketamine infusion, the periods during which a participant retained responsiveness (PreLOR), loss of responsiveness (LOR), and recovery of responsiveness were determined. Dataset 4 (neuropathological patients) adopted Coma Recovery Scale–Revised (CRS-R). Level of responsiveness is shown by the total score of six subscales (auditory, visual, motor, verbal, communication, and arousal). MCS, minimally conscious state. Error bars indicate ±SD. (**B**) Spatial maps of eight CAPs. The CAPs consist of DMN+, DAT+, FPN+, SMN+, VIS+, VAT+, GN+, and GN−. (**C**) The eight CAPs are composed of four pairs of mirror motifs with a strong negative spatial similarity, including DMN+ versus DAT+, VIS+ versus VAT+, FPN+ versus SMN+, and GN− versus GN+.

Huang2020

The default mode network (DMN) is an internally directed system that correlates with consciousness of self,

The DMN engages in a variety of internally directed processes such as autobiographical memory, imagination, and self-referencing (6–8).

the dorsal attention network (DAT) is an externally directed system that correlates with consciousness of the environment (1–7).

The DAT mediates externally directed cognitive processes such as goal-driven attention, inhibition, and top-down guided voluntary control (2, 6, 9).

the DMN and DAT appear to be in a reciprocal relationship with each other such that they are not simultaneously active, i.e., they are "anticorrelated." This anticorrelation is presumed to be vital for maintaining an ongoing interaction between self and environment that contributes to consciousness (5). Conversely, diminished anti-correlation between DMN and DAT activity has been reported in humans when consciousness was suppressed by general anesthesia (10, 11) and in neuropathological patients with disorders of consciousness (4, 12), supporting the hypothesis that a balance of the

internally and externally directed systems is important for waking
consciousness.

The eight CAPs were classified as
DMN+,
DAT+,
frontoparietal net- work (FPN+),
sensory and motor network (SMN+),
visual network (VIS+),
ventral attention network (VAT+),
and global network of activation
and deactivation (GN+ and GN−)
which have been related to arousal or vigilance fluctuations in the context of the global brain signal (35, 36).

CONCLUSIONS

This study suggests that human consciousness relies on a specific temporal circuit of dynamic brain activity characterized by balanced reciprocal accessibility of functional brain states. The disruption of this temporal circuit, exhibiting limited access to the DMN and DAT, appears to be a common signature of unresponsiveness of diverse etiologies

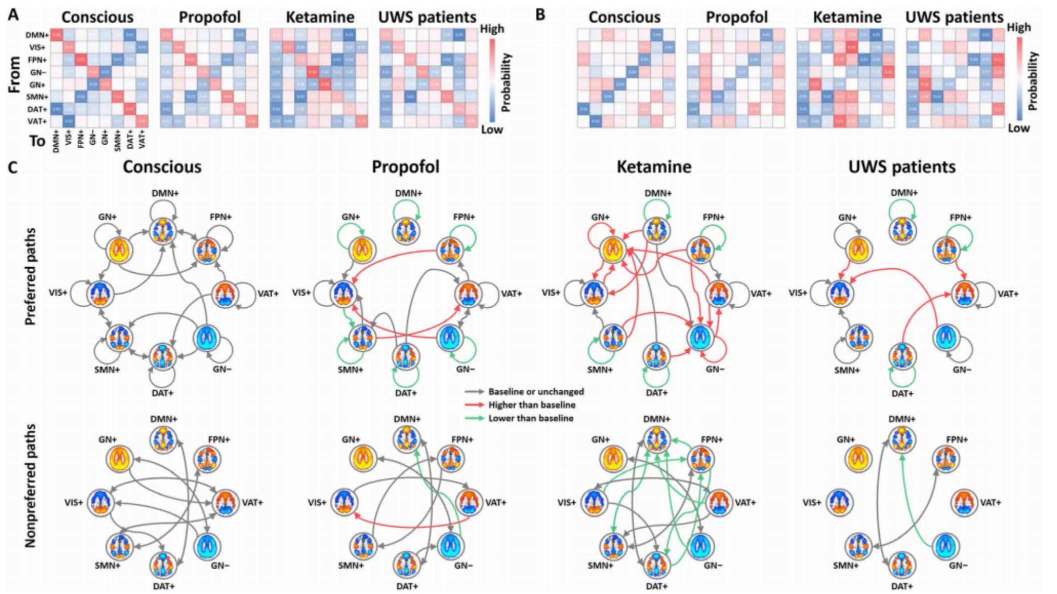


Fig. 3. Transition probabilities among CAPs. (**A**) Full transition probability matrix for conscious condition (conscious), propofol-induced unresponsiveness (propofol), ketamine-induced unresponsiveness (ketamine), and patients with UWS. The on-diagonal entries are referred to as the persistence probabilities. (**B**) Diagonal-free transition probability matrix, where the off-diagonal entries are referred to as transition probabilities by controlling for autocorrelation due to the CAP's persistence. (**C**) Schematic illustration of the significant preferred paths (>null) and nonpreferred paths (<null) for conscious versus null, propofol versus null, ketamine versus null, and patients with UWS versus null (all gray arrows). Red (higher than conscious condition) and green (lower than conscious condition) arrows indicate significant differences of persistence probabilities and transition probabilities comparing to baseline consciousness. The null model for each condition and the differences between conditions were generated by 1000 permutations across the entire dataset (see more details in Materials and Methods). Significance level was determined at $P < 0.001$ by considering multiple comparison corrections (99.9th and 0.1th percentile of the null distributions; two-sided).

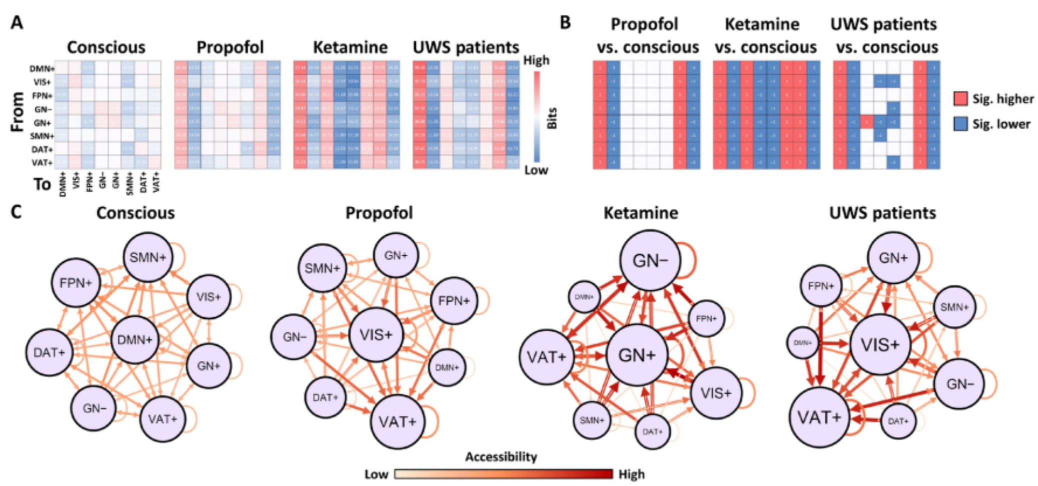
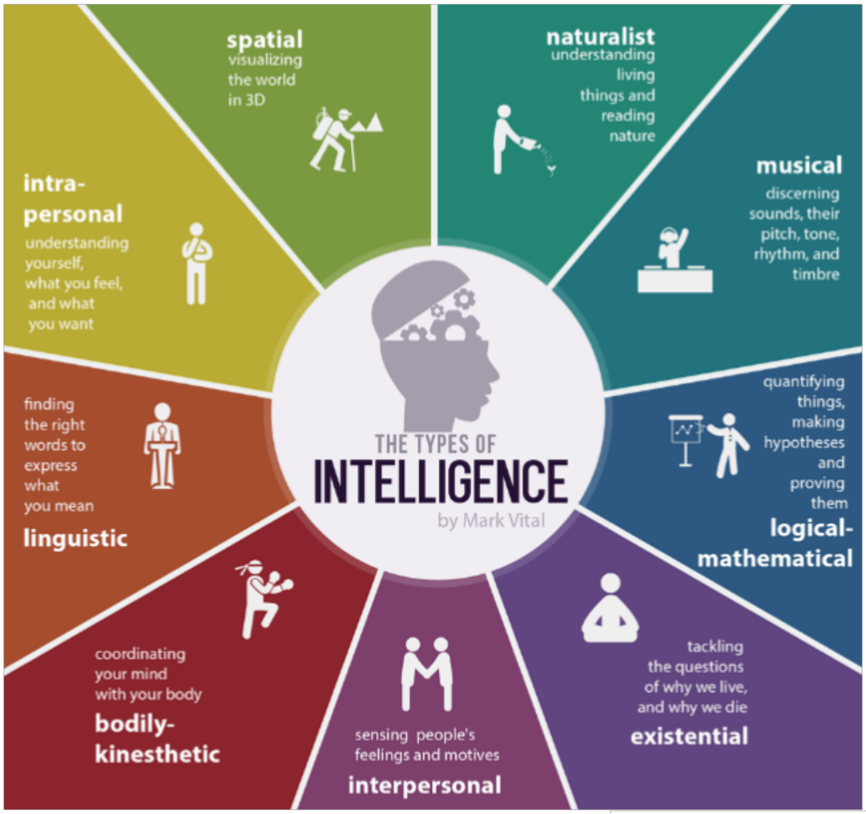


Fig. 4. Descriptive complexity of trajectories among CAPs and their in-degree accessibility. (**A**) Descriptive complexity of trajectories (in bits) between each pair of CAPs in the conscious condition (conscious), propofol-induced unresponsiveness (propofol), ketamine-induced unresponsiveness (ketamine), and in patients with UWS. (**B**) Significant differences of the descriptive complexity of trajectories for propofol versus conscious, ketamine versus conscious, and patients with UWS versus conscious. The null models were generated by 1000 permutations across the entire dataset. Significance level was determined at $P < 0.001$. (**C**) Schematic illustration for (A). The accessibility of each CAP is defined as the inverse of descriptive complexity. The node size is proportional to in-degree accessibility. The Gephi Force Atlas layout algorithm (https://gephi.org) was used.


spatial
visualizing the world in 3D
naturalist
understanding living things and reading nature
musical
discerning sounds, their pitch, tone, rhythm, and timbre
intra-personal
understanding yourself, what you feel, and what you want
THE TYPES OF
INTELLIGENCE
by Mark Vital
finding the right words to express what you mean
linguistic
quantifying things, making hypotheses and proving them
logical-mathematical
coordinating your mind with your body
bodily-kinesthetic
sensing people's feelings and motives
interpersonal
tackling the questions of why we live, and why we die
existential


Sight
Smell
Hearing
Touch
Taste

Table 1. The Five Aggregates and Their Descriptions With Examples.

Aggregate	Description	Example/s
1. Material form	Elementary components[a] that make up not only the physical body but the external environment.	Atoms and molecules that continuously move to and from the body.
2. Feelings	Subjective affective repercussions of an experience.	Pleasant, unpleasant, or neutral feelings.
3. Perception	Being aware of attributes of an object or an event.	Recognizing the color of an object, its shape, size, or any other perceptions that result from analyzing the world, our material bodies or the mind.
4. Volition[b]	Reactive or purposive aspects of the mind that include intention as well as behavior.	Volition can manifest as follows: (a) *Bodily behavior* (any activity), (b) *Verbal behavior* (speech, scolding, etc.), (c) *Psychological behavior* (proliferating thoughts, cultivating thoughts of compassion, analyzing, practicing mindfulness, etc.).
5. Sensory consciousness[c]	Being conscious of something.	Knowing a sensory stimulus (visual, tactile, olfactory, auditory, or taste) or a thought (concerning the past, present, or future).

Note. The teachings describe that all experienced moments (aggregates) are impermanent, arising, and perishing from moment to moment (Analayo, 2006).

[a]Elementary components in original teachings refer to solidity, liquidity, heat, and motion (Analayo, 2006; Bodhi, 1995).

[b]This aggregate is sometimes translated as "mental formations" (Bodhi, 1995, p. 27), as it represents a wide range of mental factors of which volition constitutes the major factor. Volition is described as having a conditioning influence on the manifestation of the other aggregates (Analayo, 2006, p. 110; Bodhi, 2006; Mahathera, 1933).

[c]Sensory consciousness can result in the generation of any of the other three mind-related aggregates. The six different ways this can happen (via the five senses or as a thought) are generally presented as "the six senses" in the Buddhist teachings (Analayo, 2006, p. 204; Bodhi, 1995, p. 27). Sensory consciousness could also trigger mental proliferation, which represents a series of mental events.